

BGS-SISAK transport-time improvements and SISAK Chemistry Experiments with ^{257}Rf

*J.P. Omtvedt, the SISAK collaboration and the LBNL Heavy Element Group**

SISAK is a fast, on-line, continuous chemical-separation system. It was developed to investigate short-lived nuclei recoiling out of an irradiated target and transported in a gas jet. The system is based on small (0.3 mL volume) centrifuges with a continuous feed and output. See [1] and references therein for details.

The first successful SISAK experiment with transactinides was performed at the LBNL 88-inch cyclotron in December 2000. The experiment proved that the SISAK system is fast enough to separate ^{257}Rf (4 s half-life) and that our Liquid Scintillation (LS) detection system is sensitive enough to detect it [2]. In March 2001 a follow-up experiment was performed, as reported here.

The December 2000 experiment gave results on the extraction of Rf into toluene [3] as a nitrate-dibutyl-phosphate complex. However, the rather long average transport time of around 18-20 s resulted in a rather low overall yield. Thus, only five extracted ^{257}Rf atoms reached the LS detectors and were detected during the two shifts used for this part of the experiment. In order to do detailed studies of the chemistry of Rf, higher yield is needed.

Therefore, the follow-up experiment in March 2001 aimed at improving the yield by:

- Reducing the volume of the recoil transfer chamber (used to transfer the recoils exiting the BGS vacuum window to the gas-jet transport system) by using N_2 gas instead of He. The stopping range is shorter in N_2 than in He.
- Increasing the gas-flow in the gas-jet transport system.
- Increasing the liquid flow through the SISAK system and the LS detectors.
- Using a separation system without a washing stage for the organic phase, e.g. extraction from dilute oxalic acid instead of the 6 M HNO_3 used in [3].

The above measures reduced the transport time significantly, by more than 5 seconds. However, the overall yield did not improve. This is attributed to non-laminar flow in the gas-jet. Therefore, in future experiments the gas-jet flow cannot be increased as much as in the experiment reported here. However, the experiments clearly indicate that significant gains can be achieved by using optimum gas and liquid flow rates. Furthermore, it is possible to gain several seconds in reduced transport time if the chemistry apparatus can be positioned closer to the BGS. With such improvements, detailed SISAK studies of the aqueous chemistry of Rf are possible and are being

planned for the summer of 2002.

In addition to the work performed to reduce the transport time, two additional experiments were done:

1. Trioctyl-amine (TOA) extraction of Rf from 0.5 M oxalic acid into 0.1 M TOA in toluene. This experiment was based on the work reported in [4]. The result indicates that Rf is extracted as its lighter homologues Zr and Hf, although with a slightly lower yield. The later might be because of the uncertainty due to the low number of Rf detected during this experiment. The experiment served as a pilot experiment for future, more detailed, studies of the Rf complexation behaviour in this chemistry.
2. Pilot experiments with ^{258}Db were performed. The aim of these experiments is to learn more about how this nuclide, and its daughters, are detected in the SISAK LS detectors. The ultimate purpose is to investigate the liquid-chemistry behaviour of Db. Further experiments are needed before this is possible, but the March 2001 experiments gave important data on how to proceed with this research. Additional experiments are planned for the summer of 2002, with an improved pulse-shape discrimination system.

References

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